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Overview of the EMFAC Emissions Inventory Model

EMFAC: A Powerful Emissions Modeling Tool for the Quantification of Pollutants from On-Road Sources

An Inventory is defined as a detailed, descriptive list or accounting of articles stating the quantity and value of each.

Using this definition, the on-road mobile source emissions inventory is simply a gathering and reporting of information about motor vehicles, their activity and emissions.

For planning purposes, however, it is not only necessary to account for present sources of emissions, the ability to predict emission rates, activity, and inventories for the future is also necessary.

To this end, mathematical models have been developed to produce inventories for conditions, places, and times in which emissions cannot readily be measured.

Over the years, stricter emission standards have been met with technological solutions of growing complexity. In response, the emission estimation models have also grown both in size and complexity. Never the less, the basic methodology for inventory estimation remains the same:

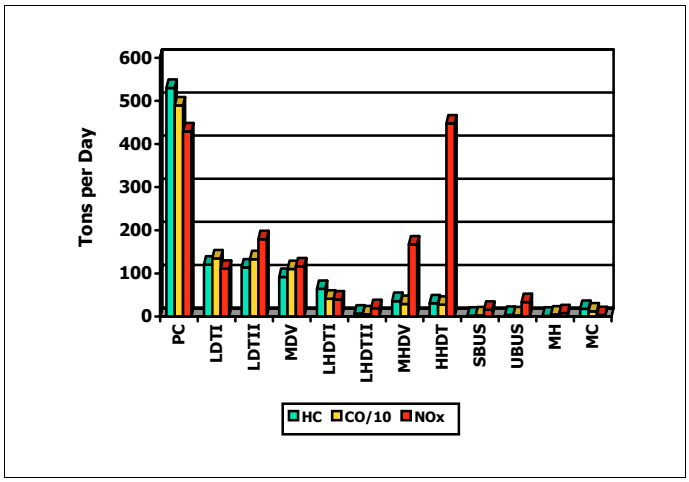
Inventory = Number of Sources* Activity* Emission Rate

EMFAC (short for **EM**ission **FAC**tor) **is a FORTRAN computer model** capable of estimating both current year, as well as back-cast and forecasted inventories for calendar years 1970 to 2040.

EMFAC estimates the emission rates of 1965 and newer vehicles, powered by either gasoline, diesel or electricity.

Emissions inventory estimates are made for over one hundred different technology groups and are reported for ten broad vehicle classes segregated by usage and weight (See Table).

The 2000 series of EMFAC expands flexibility by increasing resolution. EMFAC calculates the emission rates of HC, CO, NOx, PM, lead, SO2 and CO2 for 45 model years for each vehicle class within each calendar year, for twenty four hourly periods, for each month of the year, for each district, basin, county and sub-county in California.



Emissions Inventory by Class—Statewide in 2002

EMFAC can report the gram per mile emission rates of a single technology group or the ton per day inventory for the entire 28,000,000 vehicle California fleet.

Separate estimates can be obtained as a function of ambient temperature, relative humidity, altitude and speed.
These expanded capabilities along with the introduction of the ***"What If" Scenario*** generator (**WIS**) make EMFAC the most comprehensive, powerful and flexible model of its type.

Future refinements to EMFAC will include the incorporation of toxic air contaminants, greenhouse gases and a direct interface to travel demand models and geographic information systems.

Vehicle Class	Weight	Pop.	Vehicle Class	Weight	Pop.
Pass Cars	All	14.8 Million	**Medium-Heavy Truck**	14,001-33,000	266,000
Light Truck I	0-3,750	2.3 Million	**Heavy-Heavy Truck**	33,001+	175,000
Light Truck II	3,751-5,750	4.0 Million	**Urban Diesel Bus**	All	14,000
Medium-Duty Truck	5,751-8,500	1.7 Million	**Motorcycle**	All	331,000
Light-Heavy Truck I	8,501-10,000	272,000	**School Bus**	All	30,000
Light-Heavy Truck II	10,001-14,000	84,000	**Motor Homes**	All	166,000

Overview of the EMFAC Emissions Inventory Model

EMFAC is constructed in a "bottom-up" fashion. That is, the model is constructed from test data with no preconceived assumption regarding the end result.

Staff performs special test programs and research projects in order to isolate single variables such as speed and temperature, to determine their relative effects on emissions.

Multivariate tests are also run to determine whether interactions exists between variables. This data is ultimately reduced to mathematical equations called "Correction Factors" which are applied to a "Basic Emission Rate" or a base assumption of a vehicles emission characteristics.

Using this approach, inventory staff are not only able to estimate the emissions of different vehicles under different ambient and driving conditions, they are also able to suggest methods of control.

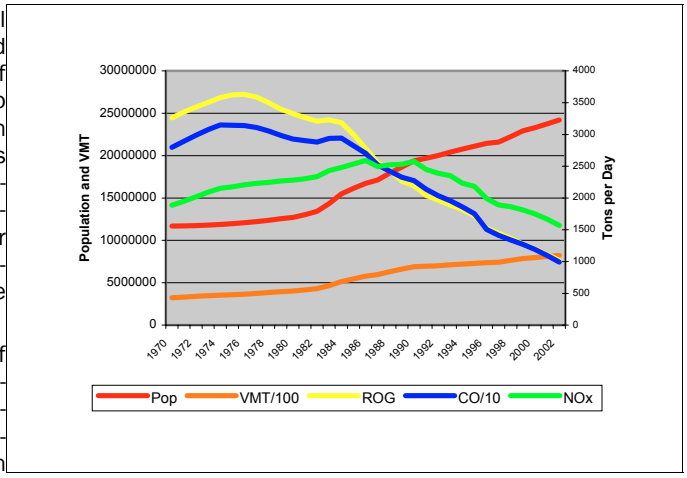
The need for estimates produced by EMFAC to be accurate also underlies its make up. Modeling staff are keenly aware that these data can impact proposed regulations for the state, and in some instances, the entire nation.

Therefore, although the model is not influenced by alternative methods of emissions estimation, extensive efforts are made to validate the emissions inventory. Senate bill 2174 requires staff to present the results of these validation efforts to the Board once every three years.

These validation efforts include comparison of model outputs with independent data sources, reconciliation of fuel consumption estimates with fuel sales and a comparison of modeled to ambient emission ratios.

The EMFAC model can be exercised over a number of calendar years to establish emission reductions trends and determine reaction of the inventory to increases or decreases in population and vehicle miles of travel.

Trend analyses of this kind are essential in assessing "progress versus plan" and in determining the effectiveness and cost effectiveness of specific emission reduction strategies or the overall effects of growth and control.



On-Road Emissions Inventory Trends—Statewide 1970-2002

EMFAC can also be run at a class specific or hourly specific rate to determine what vehicle classes might contribute inordinately to the inventory and are thus likely targets for future control, or to determine how temperature and traffic conditions might interact during the day displaying synergistic effect on the emissions of the on-road fleet.

The "WIS": What If Scenario Generation Tool

In order to facilitate the use of EMFAC as a tool to predict the impacts of changes to the air pollution control program, a powerful scenario generation subroutine, referred to as the "What If Scenario" or **WIS** has been incorporated into the latest version of the model.

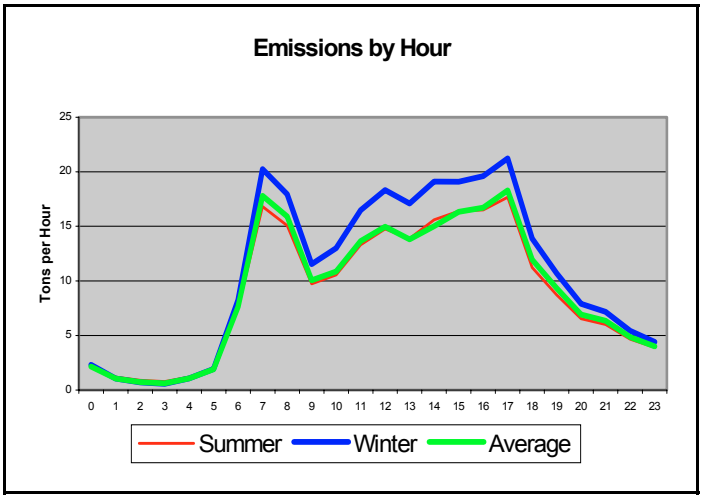
The WIS allows the user to manipulate a number of the input factors without having to recompile the source code.

"WIS"-able Edits

Vehicle Population
Vehicle Miles of Travel
Ambient Temperature
Relative Humidity
Fuel Reid Vapor Pressure
Speed Distribution
Mileage Accrual Rates
Fleet Age Distribution
Smog Check Requirements
Technology Fractions

The "WIS" utilizes a graphical user interface (GUI) to simplify the process of making alternative assumptions to the hard-coded defaults.

Work is currently underway to also allow the alteration of the basic emission rate data through the WIS in order to project the benefits of future emission standards.



The graphic on the right presents HC emissions by hour of the day. The influence of traffic is evident for both the morning and evening commutes, as well as for a lesser noontime rush.

The graphic also shows that HC emissions are higher under winter conditions than in the summer. This may suggest an interaction between lower ambient temperature and higher fuel RVP.